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(54) **A JOINT BETWEEN BEAM ELEMENTS AND COLUMN ELEMENTS MADE OF PREFABRICATED REINFORCED CONCRETE**

VERBINDUNG ZWISCHEN AUS VORGEFERTIGTEM STAHLBETON HERGESTELLTEN BALKENELEMENTEN UND SÄULENELEMENTEN

JOINT ENTRE ÉLÉMENTS DE POUTRE ET ÉLÉMENTS DE COLONNE COMPOSÉ DE BÉTON ARMÉ PRÉFABRIQUÉ

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EP 3 158 138 B1

Description

[0001] The present invention basically relates to the sector of prefabricated buildings, and in particular regards a new type of joint between beam and column elements made of prefabricated reinforced concrete, characterized by a great ease of laying *in situ* and provision of the formwork in which the concrete for completing the joint itself is poured.

[0002] Currently, there exists a type of beam-column joint that may seem similar to the joint according to the present invention, in so far as the beam is equipped with lateral end shoulders for lateral containment of the casting of the concrete that constitutes the joint, but the main difference lies in the fact that - in the known case - the current cross section of the beam is defined by the extrados of the shoulders, without any narrowing of section of the beam outside the joint.

[0003] Another type of beam-column joint is also known, the main difference of which with respect to the joint forming the subject of the present invention lies in the fact that it does not envisage the shoulders, and the cast is entirely contained by the formwork purposely provided *in situ.* In this case, there exists an evident practical difficulty of supporting the beam element before casting, so much so that the only application that is known is in experiments aimed at establishing the effectiveness of the transfer of the stresses between the re-rods, by means of the U-shaped configuration.

[0004] These different characteristics of construction, in addition to the differences of a geometrical nature, cause, especially in the first case of the known art, a substantial waste of concrete. Furthermore, in the cases referred to above it is difficult to position and support the beam conveniently during installation, and the joints that can thus be obtained do not enable restoring of the continuity of the frame in an economically advantageous way.

[0005] There is also known, from the document No. JP 2012 144936, which discloses the preamble of claim 1, a beam-column joint made of pre-fabricated reinforced concrete, in which - unlike the present invention - the re-rods are constituted by simple rectilinear lengths of iron having an anchorage head to be inserted in the joint through holes provided after installation of the beam on the column.

[0006] A better understanding of the invention will be obtained from the ensuing detailed description and with reference to the attached drawings, which illustrate, purely by way of non-limiting example, a preferred embodiment.

[0007] In the drawings:

Figure 1A is a 3D view with the reinforcements visible in through view, of the ends of a pre-fabricated beam and of a pre-fabricated column according to the present invention, during the step of constitution of the joint;
Figure 1B is a view, not of a see-through type, corresponding to the previous one;
Figure 2A is a see-through view from above of the stretches of beam and column of Figure 1;
Figure 2B is a view, not of a see-through type, corresponding to the previous one;
Figures 3A and 4A, corresponding to Figures 1 and 2 respectively, show in see-through view the beam and the column once assembly *in situ* of the joints is completed; and
Figures 3B and 4B are views, not of a see-through type, corresponding to the previous ones.

[0008] In structural terms, the characteristics of constraint that the joint guarantees are those of a perfect fixed joint.

[0009] In the embodiment according to the invention described herein, the joint is basically made up of:

1. a portion prefabricated with the beam T;
2. a portion prefabricated with the column C; and
3. a portion that can be completed *in situ.*

1. PORTION PREFABRICATED WITH THE BEAM

[0010] The beam in question typically has a rectangular section.

[0011] The section of the beam T outside the joint will be referred to in what follows as "calculation cross section".

[0012] According to the invention, at the joint, the cross section of the prefabricated beam T widens gradually and then divides into two prismatic elements with narrow rectangular cross section, referred to hereinafter as shoulders S that form an edge for containment (formwork) of the subsequent casting. In the space thus created, which according to the invention has the same cross section as the "calculation cross section", just the reinforcement is provided, made up of the longitudinal horizontal rods 1, which end in a U, and of the brackets 2, which are temporarily set up against one another at the inner end of the beam T and then, after the beam has been placed *in situ* on the column C, are designed to be arranged around the horizontal longitudinal rods 1 of the beam T and 3 of the column C, in their position predefined in the reinforced-concrete structural design stage.

[0013] The dimension in length of the compartment L depends upon the diameter of the reinforcement chosen (Φ), as illustrated in Table 1 provided below.

2. PORTION PREFABRICATED WITH THE COLUMN

[0014] Provided on the column C, in the position where the beam T is rested thereon, is a continuity reinforcement made up of rods 3 bent to form a U having the same diameter and position as the rods 1 projecting from the beam T but translated horizontally in a lateral direction with respect to the latter, just enough to enable interpenetration of this reinforcement 3 of the column C with the reinforcement 1 of the beam T, with the due constructional tolerances as illustrated in Figure 1. The rods 3 bent to form a U projecting from the column C extend in length for a stretch LU from the extrados of the column C as defined in Table 1.

TABLE 1

Φ	L1	L = L1+250 mm	LU=L1+125 mm
mm	*mm*	*mm*	*mm*
20	540	790	665
22	590	840	715
25	670	920	795
28	830	1080	955
30	890	1140	1015
32	950	1200	1075

The dimensions provided are valid for concrete for joints with f'c = 49 MPa.

[0015] In the table:

LU is the extension of the rods or (or bars) 1 or 3 outside the column C or the beam T;
L1 is the length of interpenetration of the rods (or bars) 1 and 3; and
L is the length of the compartment that contains the reinforcement of the joint to be cast *in situ*.

[0016] To obtain the dimensions with different values of strength it is necessary to multiply L1 by the ratio 7/sqrt(f'c) and update L and LU accordingly.

[0017] The column C, according to this invention, also comprises means for temporarily supporting the prefabricated beam T during installation.

[0018] In the preferred embodiment described herein, said supporting means are constituted, purely by way of example, by a short cantilever M cast together with the column C, on which cantilever the shoulders S of the beam T are rested.

3. PORTION THAT CAN BE COMPLETED *IN SITU*

[0019] Once the beam T has been set in its final position, on the provisional supporting means constituted by the above cantilever M, the brackets 2 of the reinforcement are translated into their position envisaged in the structural design.

[0020] According to the invention, the length of said cantilever M is such as to enable the operators to gain access to the compartment between the shoulders S also from beneath so as to facilitate the operations of positioning of the brackets 2 along said reinforcements 1 and 3.

[0021] Once the bottom of the compartment, confined in which are the reinforcements 1 and 3 and the corresponding brackets 2 of the joint, is closed, a provisional formwork is anchored to the shoulders S.

[0022] Casting is hence completed with a compensated-shrinkage self-levelling concrete, compounded with aggregate with a maximum grain size of 10 mm, preferably fibre-reinforced in the percentage of 0.5 vol%, the characteristic strength of which is equal to or higher than 1.65 times the characteristic strength of the concrete used for prefabrication of the beam.

Claims

1. A joint between beam elements (T) and column elements (C) made of prefabricated reinforced concrete, the joint comprising:

A) a portion prefabricated with the beam (T), equipped with projecting reinforcement rods (1) ;
B) a portion prefabricated with the column (C), equipped with projecting reinforcement rods (3), which can be

set alongside said reinforcement rods (1) of the beam (T); and
C) a portion that can be completed *in situ;*

wherein the cross section of the prefabricated beam (T), at the joint, widens gradually so that it then divides into two prismatic elements with narrow rectangular cross section, referred to as shoulders (S), which define a containment compartment, i.e., a formwork, for the subsequent casting; said containment compartment being accessible and open at the top, at the bottom, and at the front side facing the column (C), wherein said reinforcement rods (1 and 3) are arranged in mutually parallel vertical planes, where the column (C) comprises means for temporarily supporting the beam (T) during installation, **characterized in that**
the projecting reinforcement rods (1 and 3) are U-shaped and **in that** the length of the means is such as to enable the operators to gain access to the containment compartment between the shoulders (S) also from beneath the containment compartment so as to facilitate the operations of positioning of the brackets (2) along said reinforcements (1 and 3) when the beam (T) is positioned on the column (C) in its final, installed position.

2. The joint according to Claim 1, **characterized in that** in the space between the shoulders (S), which has the same cross section as the beam (T) outside the joint, only one reinforcement is provided in the beam (T), said reinforcement being made up of longitudinal horizontal rods (1), which end in a U, and of brackets (2).

3. The joint according to Claim 2, **characterized in that** provided on the column (C), in the position where the beam (T) is rested thereon, is a continuity reinforcement made up of rods (3) bent to form a U, which have the same diameter and the same position as the rods (1) of the beam (T) but are translated horizontally in a lateral direction with respect to the latter, to enable this reinforcement (3) of the column (C) and the reinforcement (1) of the beam (T) to interpenetrate.

4. The joint according to Claim 3, **characterized in that** the rods (3) bent to form a U of the column (C) extend in length from the extrados of the column (C) for a stretch (LU) that is a function of the length of overlapping (L1) of the rods (1 and 3).

5. The joint according to Claim 4, **characterized in that** the means for temporarily supporting the prefabricated beam (T) during installation, is for example, a short cantilever (M) cast together with the column (C), said cantilever functioning as resting surface for the shoulders (S) of the beam (T).

6. The joint according to Claim 5, **characterized in that** said portion that can be completed *in situ* envisages that, for closing the bottom of the compartment defined by said shoulders (S) and by the short cantilever (M) in which the reinforcements (1 and 3) of the beam (T) and of the column (C) are confined, as well as the corresponding brackets (2) of the reinforcement of the joint that are located in their position envisaged by the structural design, a provisional formwork is provided, which is anchored to the shoulders (S).

7. The joint according to Claim 6, **characterized in that** it envisages a completion casting with a compensated-shrinkage self-levelling concrete.

8. The joint according to Claim 7, **characterized in that** said concrete is compounded with aggregate of maximum grain size of 10 mm, preferably fibre-reinforced with a fibre content of 0.5 vol%, the characteristic strength of which is equal to or higher than 1.65 times the characteristic strength of the concrete used for prefabrication of the beam (T).

9. The joint according to Claim 8, **characterized in that** the dimension in length (L) of the compartment depends upon the diameter of the reinforcement chosen (Φ), as illustrated in the table below:

Φ	L1	L = L1+250 mm	LU=L1+125 mm
mm	*mm*	*mm*	*mm*
20	540	790	665
22	590	840	715
25	670	920	795
28	830	1080	955

(continued)

Φ	L1	L = L1+250 mm	LU=L1+125 mm
30	890	1140	1015
32	950	1200	1075

Patentansprüche

1. Verbindung zwischen Balkenelementen (T) und Säulenelementen (C) aus vorgefertigtem Stahlbeton, wobei die Verbindung Folgendes umfasst:

   A) einen mit dem Balken (T) vorgefertigten Abschnitt, der mit vorstehenden Bewehrungsstäben (1) versehen ist;
   B) einen mit der Säule (C) vorgefertigten Abschnitt, der mit vorstehenden Bewehrungsstäben (3) versehen ist, die entlang der Bewehrungsstäbe (1) des Balkens (T) gesetzt werden können; und
   C) einen Abschnitt, der vor Ort fertigstellbar ist;

   wobei sich der Querschnitt des vorgefertigten Balkens (T), an der Verbindung, allmählich erweitert, so dass er sich dann in zwei prismatische Elemente mit engem rechteckigen Querschnitt, die als Schultern (S) bezeichnet werden, aufteilt, die einen Einschlussraum definieren, d.h., eine Schalung, für den anschließenden Betoniervorgang; wobei der Einschlussraum oben, unten und an der der Säule (C) zugewandten Vorderseite zugänglich und offen ist, wobei die Bewehrungsstäbe (1 und 3) in zueinander parallelen vertikalen Ebenen angeordnet sind, wobei die Säule (C) ein Mittel zum vorübergehenden Abstützen des Balkens (T) während der Montage umfasst, **dadurch gekennzeichnet, dass** die vorstehenden Bewehrungsstäbe (1 und 3) U-förmig sind **und dass** die Länge des Mittels so bemessen ist, dass die Bediener Zugang zu dem Einschlussraum zwischen den Schultern (S) auch von unterhalb des Einschlussraums erhalten, um so die Operationen der Positionierung der Halterungen (2) entlang der Bewehrungen (1 und 3) zu ermöglichen, wenn der Balken (T) auf der Säule (C) in seiner endgültigen, eingebauten Position positioniert ist.

2. Verbindung nach Anspruch 1, **dadurch gekennzeichnet, dass** in dem Raum zwischen den Schultern (S), der den gleichen Querschnitt wie der Balken (T) außerhalb der Verbindung hat, nur eine Bewehrung in dem Balken (T) vorgesehen ist, die aus horizontalen Längsstäben (1), die in einem U enden, und aus Halterungen (2) besteht.

3. Verbindung nach Anspruch 2, **dadurch gekennzeichnet, dass** an der Säule (C) in der Position, in der der Balken (T) darauf aufliegt, eine Durchgangsbewehrung aus Stäben (3) vorgesehen ist, die zu einem U gebogen sind, die den gleichen Durchmesser und die gleiche Position wie die Stäbe (1) des Balkens (T) haben, jedoch horizontal in einer seitlichen Richtung zu diesem verschoben sind, damit diese Bewehrung (3) der Säule (C) und die Bewehrung (1) des Balkens (T) sich gegenseitig durchdringen können.

4. Verbindung nach Anspruch 3, **dadurch gekennzeichnet, dass** sich die zu einem U der Säule (C) gebogenen Stäbe (3) in der Länge von den Extrados der Säule (C) für eine Strecke (LU) erstrecken, die eine Funktion der Länge der Überlappung (LI) der Stäbe (1 und 3) ist.

5. Verbindung nach Anspruch 4, **dadurch gekennzeichnet, dass** das Mittel zur vorübergehenden Abstützung des vorgefertigten Balkens (T) während der Montage beispielsweise ein kurzer Ausleger (M) ist, der zusammen mit der Säule (C) gegossen ist, wobei der Ausleger als Auflagefläche für die Schultern (S) des Balkens (T) dient.

6. Verbindung nach Anspruch 5, **dadurch gekennzeichnet, dass** der Abschnitt, der vor Ort fertigstellbar ist, vorsieht, dass, zum Schließen des Bodens des durch die Schultern (S) und den kurzen Ausleger (M) definierten Einschlussraums, in dem die Bewehrungen (1 und 3) des Balkens (T) und der Säule (C) begrenzt sind, als auch die entsprechenden Halterungen (2) der Bewehrung der Verbindung, die sich in der von der Tragwerksplanung vorgesehenen Lage befinden, eine provisorische Schalung vorgesehen ist, die an den Schultern (S) verankert ist.

7. Verbindung nach Anspruch 6, **dadurch gekennzeichnet, dass** sie einen Fertigguss mit einem Schrumpfkompensations-Selbstnivellierbeton vorsieht.

8. Verbindung nach Anspruch 7, **dadurch gekennzeichnet, dass** der Beton mit einem Zuschlagstoff mit einer maxi-

malen Korngröße von 10 mm, vorzugsweise faserverstärkt mit einem Fasergehalt von 0,5 Vol.-%, dessen charakteristische Festigkeit gleich oder höher als das 1,65-fache der charakteristischen Festigkeit des für die Vorfertigung des Balkens (T) verwendeten Betons ist, verbunden ist.

9. Verbindung nach Anspruch 8, **dadurch gekennzeichnet, dass** das Längenmaß (L) des Raums vom Durchmesser der gewählten Bewehrung (Φ) abhängt, wie in der nachstehenden Tabelle dargestellt ist:

Φ	L1	L = L1+250 mm	LU=L1+125 mm
mm	*mm*	*mm*	mm
20	540	790	665
22	590	840	715
25	670	920	795
28	830	1080	955
30	890	1140	1015
32	950	1200	1075

Revendications

1. Joint entre des éléments de poutre (T) et des éléments de colonne (C) réalisés en béton armé préfabriqué, le joint comprenant :

A) une partie préfabriquée avec la poutre (T), équipée de tiges de renforcement en saillie (1) ;
B) une partie préfabriquée avec la colonne (C), équipée de tiges de renforcement en saillie (3), qui peuvent être placées côte à côte avec lesdites tiges de renforcement (1) de la poutre (T) ; et
C) une partie qui peut être achevée in situ ;

dans lequel la section transversale de la poutre préfabriquée (T), au niveau du joint, s'élargit progressivement de manière qu'elle se divise ensuite en deux éléments prismatiques avec section transversale rectangulaire étroite, désignés comme des épaulements (S), qui définissent un compartiment de confinement, c'est-à-dire un coffrage, pour la coulée subséquente ; ledit compartiment de confinement étant accessible et ouvert au niveau du sommet, au niveau du fond et au niveau du côté avant faisant face à la colonne (C), dans lequel lesdites tiges de renforcement (1 et 3) sont agencées dans des plans verticaux mutuellement parallèles, où la colonne (C) comprend des moyens pour supporter temporairement la poutre (T) durant l'installation, **caractérisé en ce que** les tiges de renforcement en saillie (1 et 3) sont en forme de U et **en ce que** la longueur des moyens est telle qu'elle permette aux opérateurs d'avoir accès au compartiment de confinement entre les épaulements (S) également en dessous du compartiment de confinement de manière à faciliter les opérations de positionnement des équerres (2) le long desdits renforcements (1 et 3) quand la poutre (T) est positionnée sur la colonne (C) dans sa position installée finale.

2. Joint selon la revendication 1, **caractérisé en ce que** l'espace entre les épaulements (S), qui a la même section transversale que la poutre (T) en dehors du joint, seul un renforcement est prévu dans la poutre (T), ledit renforcement étant composé de tiges horizontales longitudinales (1), qui se terminent en U, et d'équerres (2).

3. Joint selon la revendication 2, **caractérisé en ce qu'**il est prévu sur la colonne (C), dans la position où la poutre (T) est appuyée dessus, un renforcement de continuité composé de tiges (3) pliées pour former un U, qui ont le même diamètre et la même position que les tiges (1) de la poutre (T) mais sont décalées horizontalement dans une direction latérale par rapport à ces dernières, pour permettre à ce renforcement (3) de la colonne (C) et au renforcement (1) de la poutre (T) de s'interpénétrer.

4. Joint selon la revendication 3, **caractérisé en ce que** les tiges (3) pliées pour former un U de la colonne (C) s'étendent en longueur de l'extrados de la colonne (C) sur un tronçon (LU) qui est une fonction de la longueur de chevauchement (L1) des tiges (1 et 3).

5. Joint selon la revendication 4, **caractérisé en ce que** des moyens pour supporter temporairement la poutre préfabriquée (T) durant l'installation sont, par exemple, un élément en porte-à-faux court (M) coulé conjointement à la colonne (C), ledit élément en porte-à-faux fonctionnant comme une surface d'appui pour les épaulements (S) de la poutre (T).

6. Joint selon la revendication 5, **caractérisé en ce que** ladite partie qui peut être achevée in situ prévoit que, pour la fermeture du dessous du compartiment défini par lesdits épaulements (S) et par l'élément en porte-à-faux court (M) dans lequel les renforcement (1 et 3) de la poutre (T) et de la colonne (C) sont confinés, ainsi que les équerres correspondantes (2) du renforcement du joint qui sont situés dans leur position prévue par la conception structurale, il est prévu un coffrage qui est ancré aux épaulements (S).

7. Joint selon la revendication 6, **caractérisé en ce qu'**il est prévu une coulée d'achèvement avec un béton autonivelant à retrait compensé.

8. Joint selon la revendication 7, **caractérisé en ce que** ledit béton est composé d'un granulat avec une granulométrie maximale de 10 mm, de préférence renforcé par des fibres avec une teneur en fibres de 0,5 % en volume, dont la résistance caractéristique est égale ou supérieure à 1,65 fois la résistance caractéristique du béton utilisé pour la préfabrication de la poutre (T).

9. Joint selon la revendication 8, **caractérisé en ce que** la dimension en longueur (L) du compartiment dépend du diamètre du renforcement choisi (Φ), comme illustré dans le tableau ci-dessous :

Φ	L1	L = L1+250 mm	LU=L1+125 mm
mm	*mm*	*mm*	*mm*
20	540	790	665
22	590	840	715
25	670	920	795
28	830	1080	955
30	890	1140	1015
32	950	1200	1075

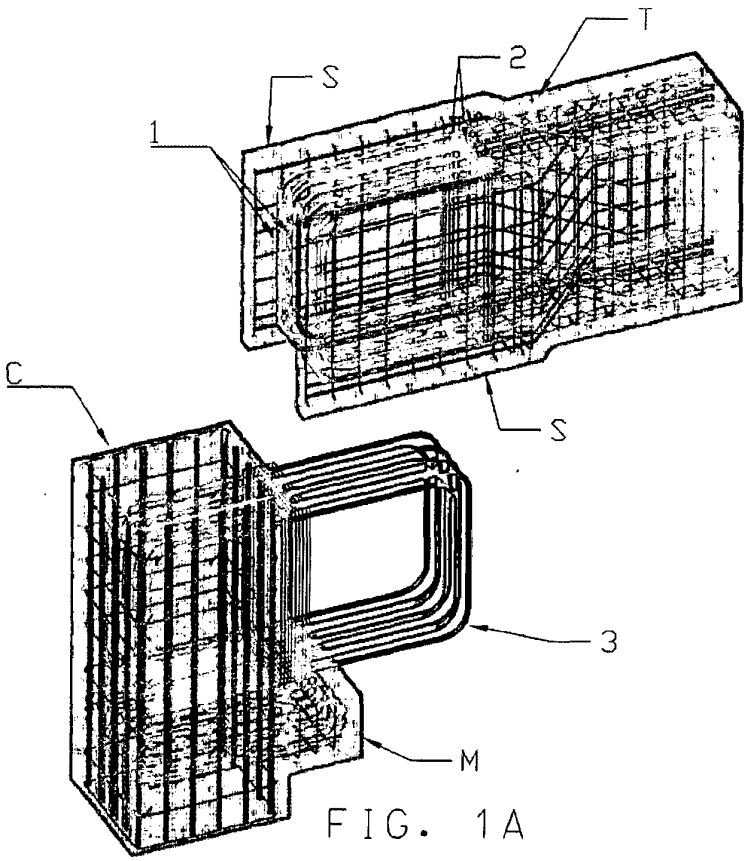

FIG. 1A

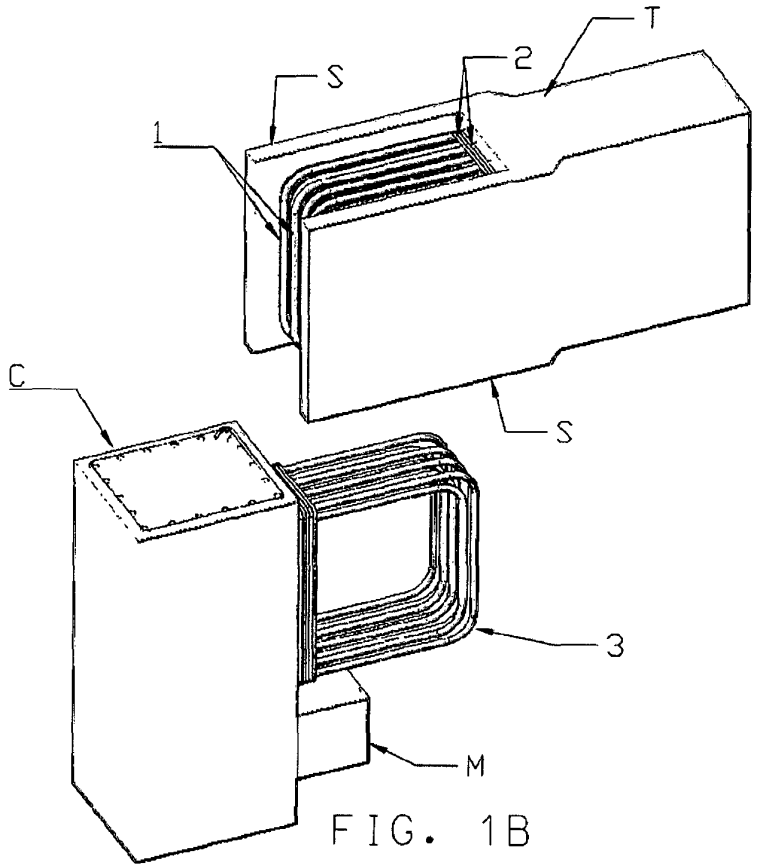

FIG. 1B

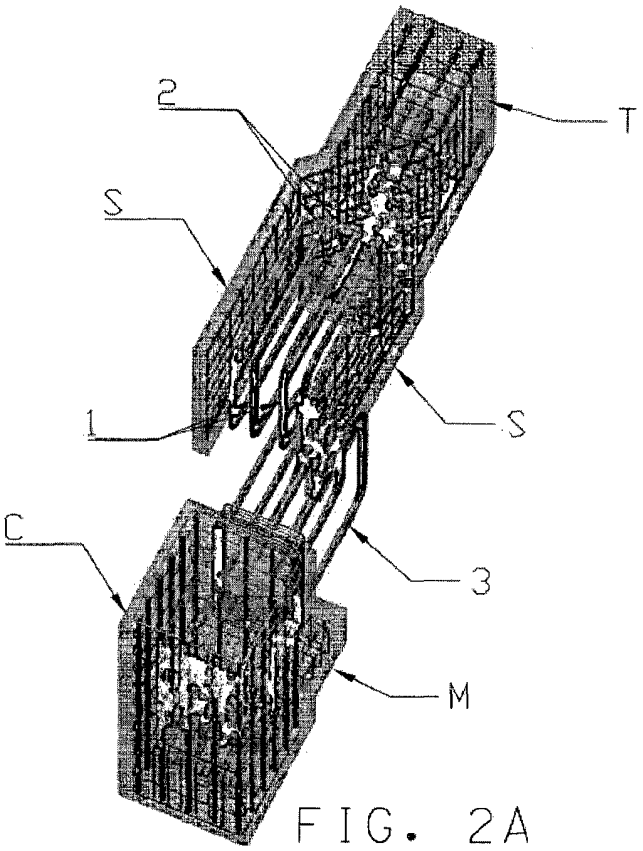

FIG. 2A

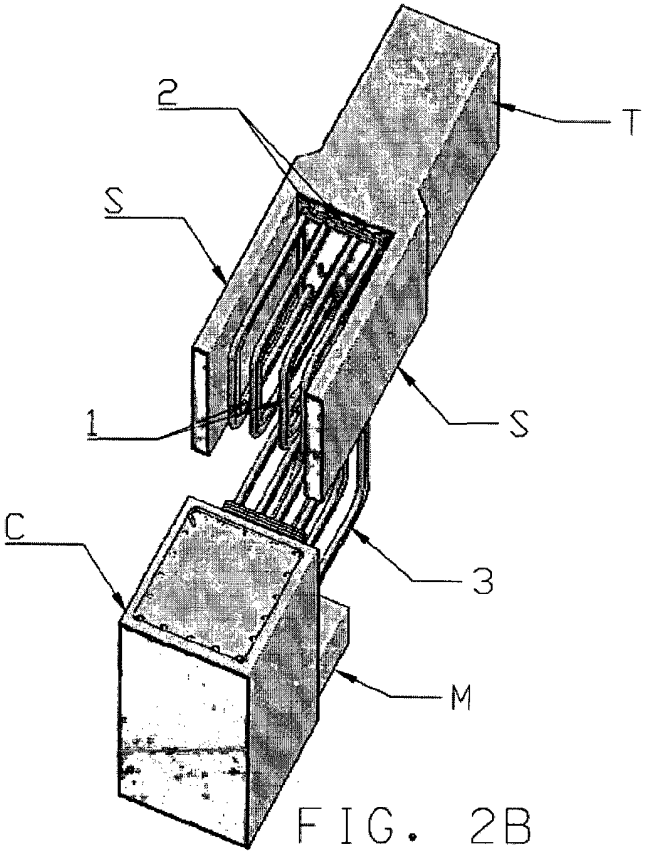

FIG. 2B

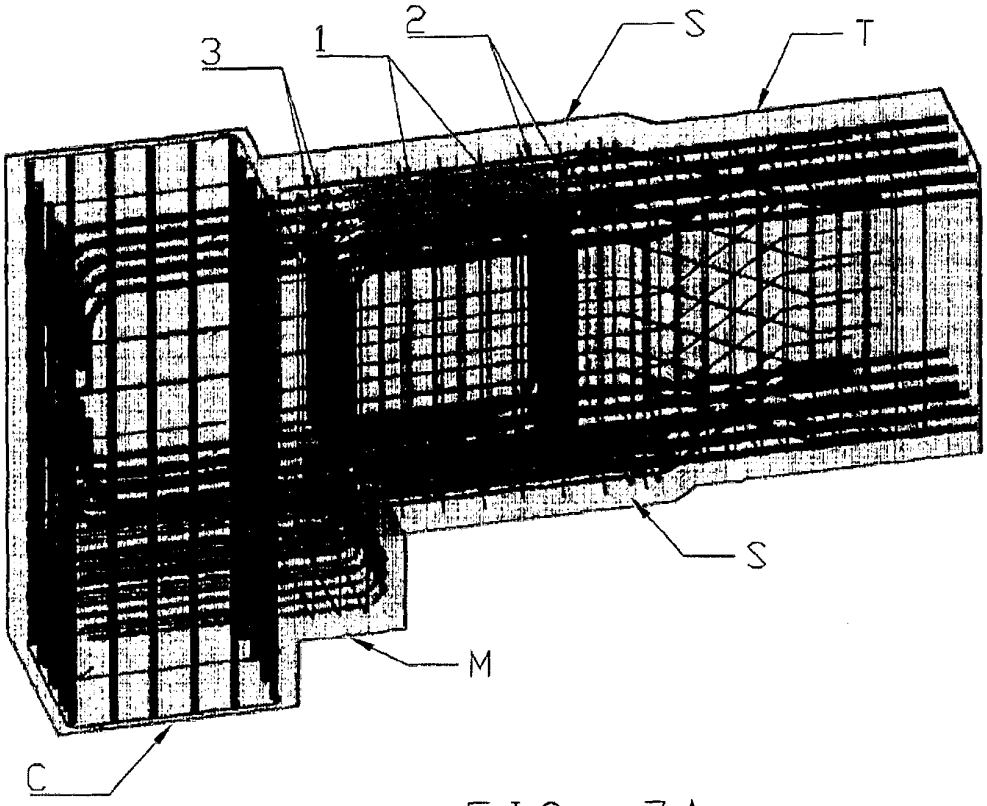

FIG. 3A

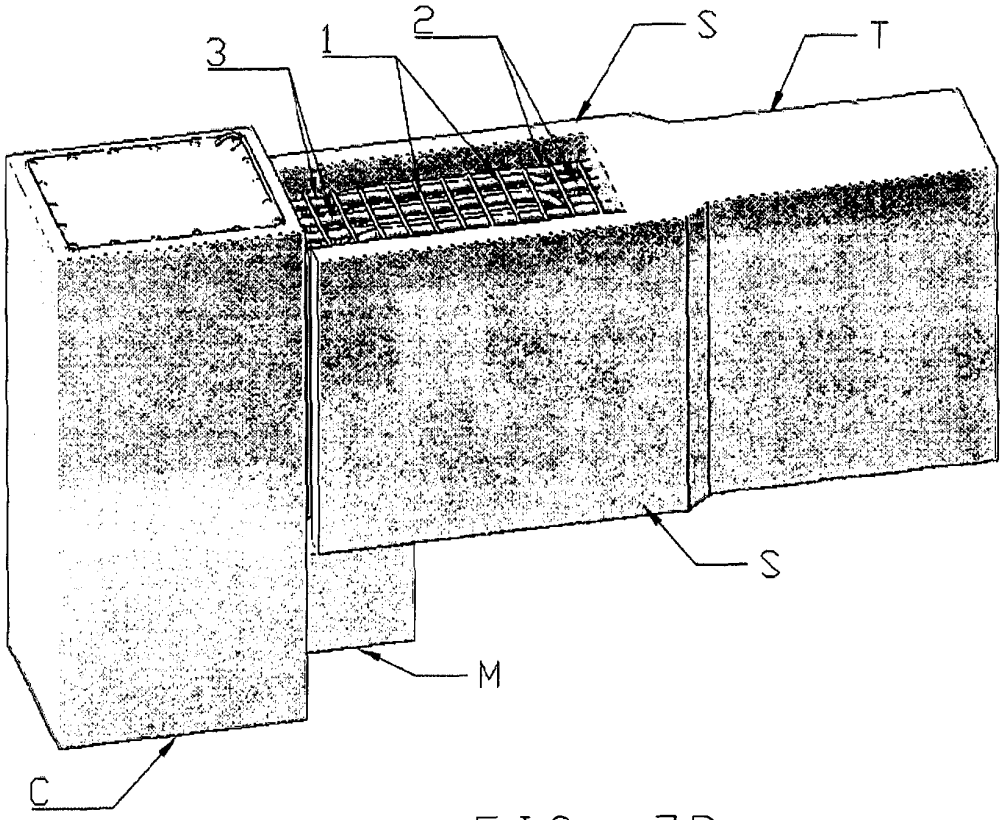

FIG. 3B

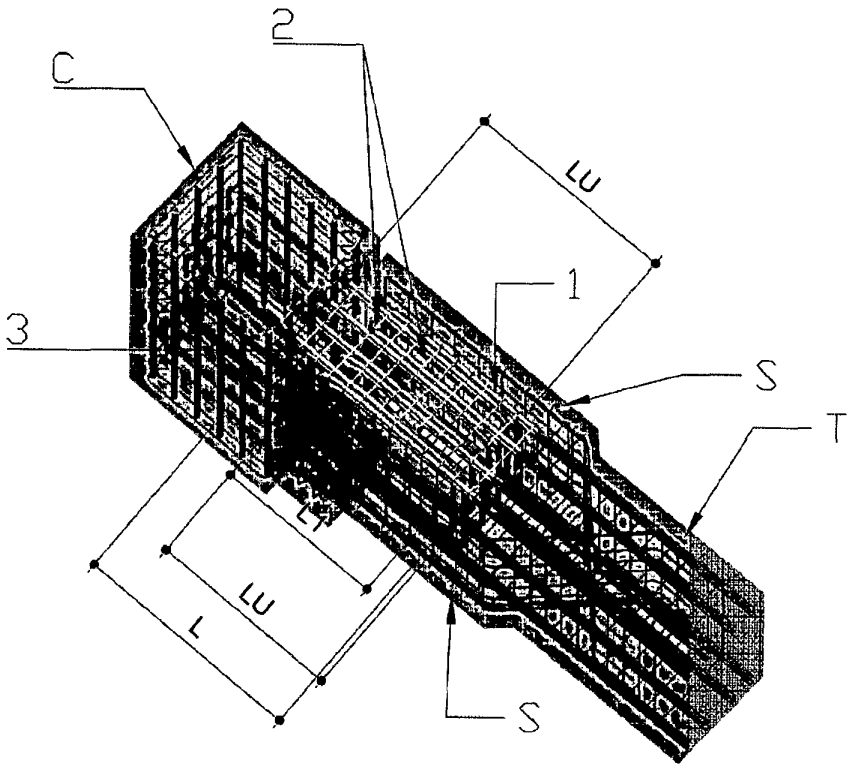

FIG. 4A

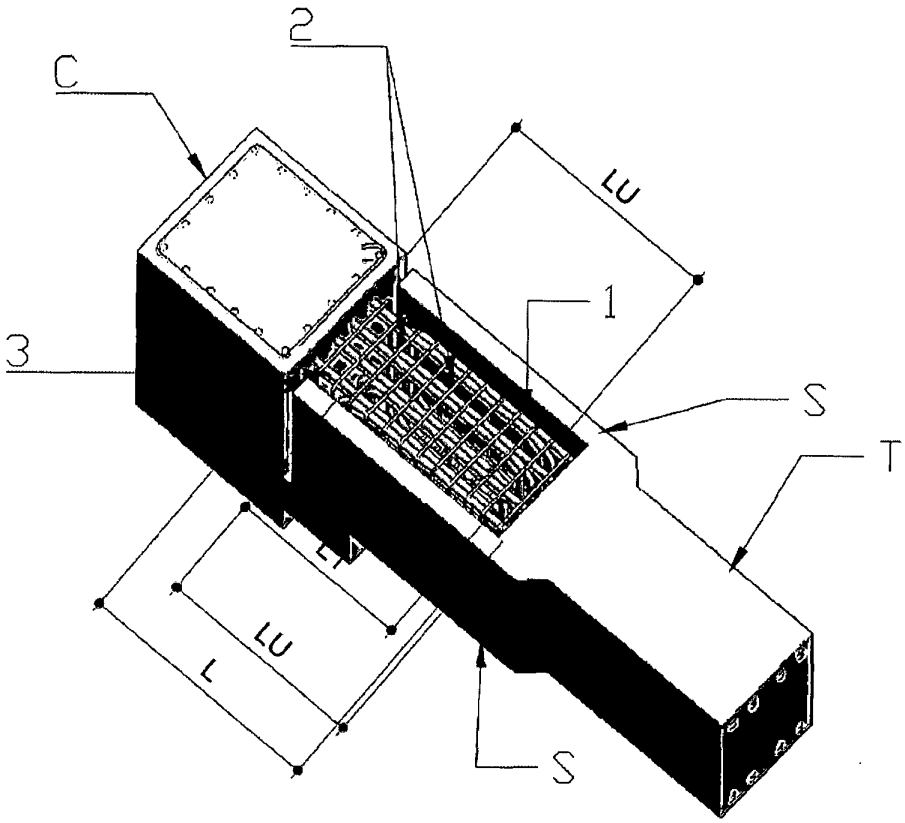

FIG. 4B

REFERENCES CITED IN THE DESCRIPTION

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